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### ASSIGNMENT BOOKLET

SCN2242 Chemistry 20

Module 3 Assignment

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Teacher

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# Chemistry 20

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Module 3

## BEHAVIOUR OF GASES

*ASSIGNMENT BOOKLET*

## FOR TEACHER'S USE ONLY

### Summary

|                        | Total<br>Possible<br>Marks | Your<br>Mark |
|------------------------|----------------------------|--------------|
| Lesson 1<br>Assignment |                            |              |
| Lesson 2<br>Assignment |                            |              |
| Lesson 4<br>Assignment |                            |              |
|                        |                            |              |

### Teacher's Comments

Chemistry 20  
Module 3: Behaviour of Gases  
Assignment Booklet  
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|                               |   |
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| Teachers                      | ✓ |
| Administrators                |   |
| Home Instructors              |   |
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| Other                         |   |



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## **MODULE 3: LESSON 1 ASSIGNMENT**

### **Lesson 1 Assignment: Properties of Gases and Boyle's Law**

#### **Part 1: Lab: Boyle's Law**

##### **Procedure 1**

Place data from investigation in the Answer box below.

**Procedure 1**

1. According to Boyle's law, pressure is inversely proportional to volume. Prepare a graph of the data for propane with  $[1/\text{volume}]$  (units=1/mL) on the X-axis and pressure (kPa) on the Y-axis. Draw a straight line through the data points.
2. Does your experimental data verify Boyle's law? Explain.
3. What pressure would the gas sample have at a volume of 75 mL? At 300 mL?
4. List two sources of possible error that could influence your results.

**Procedure 2**

1. According to Boyle's law, pressure is inversely proportional to volume. Prepare a graph of the data for butane with  $[1/\text{volume}]$  (units =  $1/\text{mL}$ ) on the x-axis and pressure (kPa) on the y-axis. Draw a straight line through the data points.
2. Does your experimental data verify Boyle's law? Explain.
3. What pressure would the gas sample have at a volume of 75 mL? At 300 mL?

4. How do the results for butane compare with those for propane? Does each gas obey Boyle's law? Use the data contained on the graph to justify your answer.

## Part 2

1. A 10.0-g sample of carbon monoxide, a poisonous gas produced by the incomplete combustion of hydrocarbons, occupies 15.0 L at a pressure of 200 kPa. The volume occupied by the carbon monoxide when the pressure is increased to 700 kPa is
  - A. 1.16 L
  - B. 4.05 L
  - C. 4.29 L
  - D. 52.5 L
2. A student filled a balloon with a gas at a pressure of 100.0 kPa and determines its volume to be 1.44 L. Calculate the volume of the balloon if the pressure increases to 112.3 kPa.
  - A. 1.04 L
  - B. 1.28 L
  - C. 1.44 L
  - D. 1.61 L
3. The pressure of a fixed mass of gas is increased from 100 kPa to 400 kPa at a constant temperature. The new volume of the gas is
  - A. one-half the original volume
  - B. two times the original volume
  - C. four times the original volume
  - D. one-fourth the original volume

4. In Vancouver, where the air pressure is 101 kPa, a child is given a 2.0-L balloon. The family then drives to Banff, which is 1386 m above sea level and the air pressure is only 87 kPa. If the temperature is the same in both places, the volume of the balloon in Banff is
- A. 1.7 L
  - B. 2.0 L
  - C. 2.3 L
  - D. 4.0 L
5. Multiply each measurement by the appropriate conversion factor to change from one unit to another.
- a. Convert 0.68 bars into units of kPa.
  - b. Convert 209 kPa into units of atm.
  - c. Convert 550 torr into kPa.

6. A sample of gas is initially at a pressure of 5.2 atm and has a volume of 2.8 mL. Determine the new volume if the pressure of the gas is increased to 8.0 atm.
7. A sample of gas has a volume of 2.4 L. Determine the new volume of the gas if the pressure is halved.
8. A sample of gas has a volume of 7.5 L. Determine the new volume of the gas if the pressure is increased by a factor of 5.

**MODULE 3: LESSON 2 ASSIGNMENT****Lesson 2 Assignment: Kelvin Temperature, Charles' Law, and the Combined Gas Law****Part 1: Lab: Charles' Law****Data**

Record the data collected from the investigation.

| Gas     | Temperature (k) | Volume (mL) |
|---------|-----------------|-------------|
| Methane |                 |             |
| Butane  |                 |             |

**Procedure 1**

1. Prepare a graph of the data for methane with temperature (in kelvin) on the x-axis and volume (mL) on the y-axis.
2. Draw a straight line through the data points.
3. Does your experimental data verify Charles' law?

4. What volume would the gas sample occupy at 50°C and at 120°C?
  
  
  
  
  
  
  
  
  
  
5. List two sources of possible error if you had done the activity in a real lab.

**Procedure 2**

1. Prepare a graph of the data for butane with temperature (in kelvin) on the x-axis and volume (mL) on the y-axis.

2. Draw a straight line through the data points.
3. Does your experimental data verify Charles' law?
4. What volume would the gas sample occupy at 0°C and at 70°C?
5. List two sources of possible error if you had done the activity in a real lab.

## Part 2

1. As the temperature of a fixed volume of a gas decreases, the pressure will
  - A. increase
  - B. decrease
  - C. not change
  - D. vary inversely
2. The boiling point of liquid nitrogen is  $-196^{\circ}\text{C}$ . An equivalent temperature in the Kelvin scale is
  - A.  $-196\text{ K}$
  - B.  $77\text{ K}$
  - C.  $153\text{ K}$
  - D.  $273\text{ K}$

3. The scientist who is credited with the statement "At constant pressure, the volume of a gas is directly proportional to the kelvin temperature" is
- A. Boyle
  - B. Dalton
  - C. Charles
  - D. Avogadro
4. A weather balloon on the ground has a volume of 200 L at 25.0°C when filled with helium to a pressure of 100 kPa. The volume of the balloon at 9000 m, where the temperature is -50.0°C and the pressure is 19.5 kPa, is
- A. 1.35 mL
  - B. 29.6 L
  - C. 51.2 L
  - D. 768 L
5. A 2.0-L helium tank at a pressure of 15.0 MPa in a room kept at 22°C is used to blow up balloons. The balloons, once blown up, have a volume of 2.0 L and maintain a pressure of 115 kPa without breaking. The maximum number of balloons that can be filled with this tank is
- A. 100
  - B. 130
  - C. 260
  - D. 380
6. Read the following list of conditions and temperatures.
- I. The boiling point of water is 373 K.
  - II. On a very hot day, the temperature can reach 313 K.
  - III. On a very cold day, the temperature can reach 0 K.
  - IV. Normal body temperature is 310 K.
- The conditions listed with accurate temperatures are
- A. I and IV
  - B. I, II, and III
  - C. I, II, and IV
  - D. II, III, and IV
7. A gaseous fluorocarbon is used as a coolant in refrigerators. If a fixed volume of this gas has a pressure of 700 kPa at 227°C, its pressure at 27°C is
- A. 83 kPa
  - B.  $4.2 \times 10^2$  kPa
  - C.  $1.2 \times 10^3$  kPa
  - D.  $5.9 \times 10^3$  kPa

8. A gas has a volume of 2.1 L at SATP. What will be the volume of the gas if the temperature is cooled to  $-30.5^{\circ}\text{C}$  and the pressure is held constant?
  
  
  
  
  
  
  
  
  
  
9. A gas has a volume of 3.4 L. What is the new volume if the temperature is doubled?
  
  
  
  
  
  
  
  
  
  
10. A gas has a volume of 4.5 L at STP. If the conditions are changed to SATP, what is the new volume of the gas?
  
  
  
  
  
  
  
  
  
  
11. A metal container contains a gas that is fixed in volume. If the pressure is initially 650 mm Hg and the temperature is increased from 480 K to 700 K, what is the new pressure?

**MODULE 3: LESSON 4 ASSIGNMENT****Lesson 4 Assignment: Molar Volume and the Ideal Gas Law****Part 1: Lab: Molar Volume of a Gas****Data**

Record the data collected from the experiment in the table below.

|                                                                      |  |
|----------------------------------------------------------------------|--|
| Mass of zinc used (g)                                                |  |
| Molecular weight of zinc (g/mol)                                     |  |
| Volume of 6 mol/L HCL (mL)                                           |  |
| Initial pressure inside flask                                        |  |
| Maximum pressure reached during the experiment                       |  |
| Initial temperature inside flask                                     |  |
| Maximum temperature reached during the experiment                    |  |
| Final pressure in the gas piston at the conclusion of the experiment |  |
| Volume of gas collected in the piston                                |  |

**Analysis**

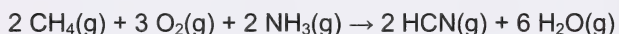
1. Calculate the following:
  - a. moles of zinc reacted

- b. moles of hydrogen produced
  - c. molar volume of the ideal hydrogen gas at room temperature (final volume in the gas piston / moles of hydrogen gas), expressed as L/mol
2. a. Compare the experimental value for the molar volume at 21°C with the value of 24.5 L/mol (listed in the Background section of the lab manual) using the following formula:
- $$\% \text{ error} = (\text{experimental molar volume} - \text{predicted molar volume}) / \text{predicted molar volume} * 100\%$$

- b. In your opinion, is the percentage error acceptable? What may have been a source of error in this experiment? How does this compare to your hypothesis?

## Part 2

1. Hydrogen cyanide gas is produced industrially by this reaction:



What volumes of  $\text{O}_2(\text{g})$  and  $\text{NH}_3(\text{g})$  are needed to react with 8.0 L of  $\text{CH}_4(\text{g})$  at STP?

- A. 12 L of  $\text{O}_2(\text{g})$  and 8 L of  $\text{NH}_3(\text{g})$   
B. 4 L of  $\text{O}_2(\text{g})$  and 8 L of  $\text{NH}_3(\text{g})$   
C. 8 L of  $\text{O}_2(\text{g})$  and 12 L of  $\text{NH}_3(\text{g})$   
D. 12 L of  $\text{O}_2(\text{g})$  and 4 L of  $\text{NH}_3(\text{g})$
2. Use the following balanced equation to answer the question.
- $$2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{g})$$
- If 10.0 L of hydrogen reacted with 5.0 L of oxygen, the volume of water vapour formed is
- A. 2.0 L  
B. 5.0 L  
C. 10 L  
D. 15 L
3. Three 1.0-L flasks contain  $\text{He}(\text{g})$ ,  $\text{N}_2(\text{g})$ , and  $\text{H}_2\text{S}(\text{g})$  at SATP. Which statement indicates the relative number of molecules in the flasks?
- A. The flask of  $\text{He}(\text{g})$  contains the most molecules.  
B. The flask of  $\text{N}_2(\text{g})$  contains the most molecules.  
C. The flask of  $\text{H}_2\text{S}(\text{g})$  contains the most molecules.  
D. All three flasks contain the same number of molecules.

4. Hydrogen sulfide gas is combusted with oxygen gas to produce sulfur dioxide gas and water vapour. If there is 48.4 L of oxygen available, what volume of hydrogen sulfide gas may be combusted if the pressure is held constant at 105 kPa and the temperature is held constant at 190°C?
  
  
  
  
  
  
  
  
  
  
5. Butane gas is combusted to produce carbon dioxide and water vapour. If 5.50 mol of butane are reacted, how many moles of water vapour are produced?
  
  
  
  
  
  
  
  
  
  
6. Ammonia is produced from its elements in a formation reaction. If  $8.90 \times 10^{24}$  molecules of ammonia are produced, how many molecules of hydrogen were used?
  
  
  
  
  
  
  
  
  
  
7. Hydrogen gas can be used in weather balloons because of its low density. The volume occupied by 3.00 mol of hydrogen at SATP is
  - A. 6.23 L
  - B. 67.2 L
  - C. 73.6 L
  - D. 74.4 L
  
  
  
  
  
  
  
8. A 2.50-L balloon contains 0.100 mol of air at 115 kPa pressure. The temperature of the air in the balloon is
  - A. 30°C
  - B. 73°C
  - C. 100°C
  - D. 346°C

9. Examine the following statements made by students.
- I. Pressure is directly proportioned to temperature when all other variables are held constant.
  - II. Pressure is directly proportioned to volume when all other variables are held constant.
  - III. Volume is directly proportioned to temperature when all other variables are held constant.
  - IV. The number of moles is directly proportioned to volume when all other variables are held constant.

Which statements apply to ideal gases?

- A. I and II
  - B. II and III
  - C. I and III
  - D. I, III, and IV
10. Chlorine, a poisonous yellow gas, can be produced by mixing vinegar and bleach for a cleaning solution. The volume occupied by 150 g of chlorine at  $-12.5^{\circ}\text{C}$  and 98.5 kPa is
- A. 46.5 L
  - B. 47.4 L
  - C. 52.5 L
  - D. 93.0 L
11. Carbon dioxide gas is sometimes used to carbonate beverages. A sample of carbon dioxide occupies a volume of 180 mL at  $35.0^{\circ}\text{C}$  and 88.9 kPa. The volume occupied by the gas at STP is
- A. 140 mL
  - B. 155 mL
  - C. 178 mL
  - D. 181 mL
12. Helium gas is contained in a tank with a pressure of 12.4 MPa. If the temperature inside the tank is  $32.8^{\circ}\text{C}$  and the volume of the tank is 18.0 L, determine the mass of helium in the tank.

13. If 77.60 g of nitrogen gas are produced in a reaction, what is the volume if the temperature is 48°C and the pressure is 99.5 kPa?

**Once you have completed all of the questions, submit your work to your teacher.**

There are two main types of data: qualitative and quantitative.



